When considering the problem of thermal energy transfer in the regoliths of airless bodies, both radiative and conductive transfer must be considered. In the past radiative transfer has been addressed by adding a T^3 term to the conductivity, but this approximation is only valid when the modeled medium is in radiative equilibrium, which is not the case for the near-surface layers of a regolith. To rigorously account for radiative transfer as well as conductive transfer of thermal energy in a regolith, the radiative transfer and heat transfer equations must be solved simultaneously. Such a model allows for determination of the thermal inertia of a regolith, as did previous conduction-only models, but also allows for constraint of a new parameter, which we term the radiative resistivity. Knowledge of this parameter in turn makes estimates of grain size possible from remote observation of surface temperature versus time curves. This model also predicts an enhancement of the conductivity of the regolith of an airless planet during the day when the temperature is high, and a corresponding reduction in its conductivity at night due to the highly temperature dependent nature of radiative energy transfer. In practice, this means that heat is more easily shunted from the surface to depth than would otherwise be the case during the day, but is trapped in the subsurface at night. Our model also predicts that the subsurface polar regions of both the Moon and Mercury may be sufficiently cold to have harbored water ice over geologic time scales.